Washington State Department of Transportation

Washington State Ferries

WSF Vessel Planning and The Keystone Route Decision

I. Vessel Planning

Overview

This paper addresses the rationale behind WSF's recommendation to replace older smaller vessels in its fleet with a modern, more flexible and interchangeable fleet of medium size vessels with much more efficient operating characteristics. It further documents how that decision affects the service and terminal infrastructure requirements of the Port Townsend/Keystone route.

Background – What Is The Current Vessel Situation?

WSF currently has seven passenger-vehicle ferry classes, the Jumbo Class (two Mark I and three Mark II), Super Class (4), Expanded Issaquah Class (5), Issaquah Class (1), Evergreen State Class (3), Steel Electric Class (4), and Miscellaneous Class (2). There are also two classes of passenger-only vessels, the Monohulls (2) and Passenger-Only Fast Ferries (POFF, of which there are two). This paper will focus on passenger-vehicle ferries and not passenger-only ferries.

Figure 1 shows the relative age of the fleet. Almost unheard of among world ferry operators, WSF owns four vessels constructed in the 1920's and another constructed in the 1940's. These vessels are currently in service on three routes: San Juan inter-island, Port Townsend/Keystone, and Point Defiance/Tahlequah.

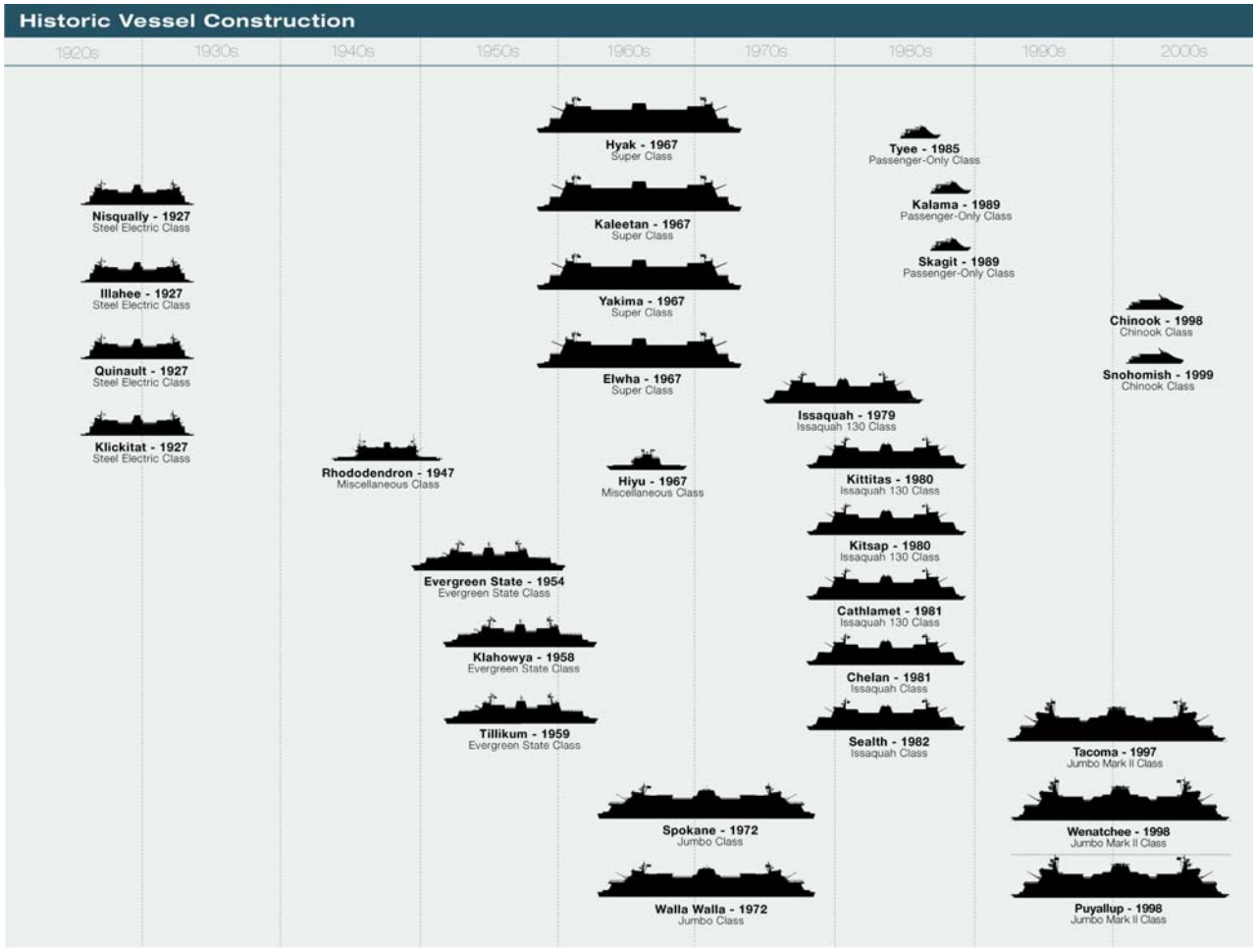
The San Juan inter-island route is currently served by the 64-car MV Illahee. Although capacity is currently adequate during the fall-winter-spring season, the vessel's size and speed prove a challenge when trying to meet summer traffic demand and would prove to be more so as traffic grows on the route.

The Port Townsend/Keystone route is served year-round by the 64-car MV Klickitat, scheduled for 16 hours of service per day, and is supplemented by the 64-car MV Quinault during the peak season mid-May through mid-October for eight hours per day. The eight hour shift on the second vessel is scheduled from mid-morning through late

afternoon (the peaking characteristics on this route are different than most commuter oriented routes). On Fridays and Sundays the eight hour shift with the second boat is shifted one round trip later to better cover late afternoon/early evening weekend traffic.

The Point Defiance/Tahlequah route is currently served by the 60-car MV Rhododendron. The vessel operates for 16 hours per day, although service is suspended for a couple of hours during the early afternoon to allow more late evening service coverage. The vessel typically leaves vehicles behind on most commuter sailings; traffic is forecast to grow on this route in the future.

Figure 1 – fleet age distribution graphic



All of these vessels face significant preservation costs over the next decade. Rather than investing in preserving these obsolete vessels, Washington State Ferries has embarked on a course to replace them with ones more suitable to modern traffic requirements and regulatory environment. When evaluating future fleet needs in the context of replacing these vessels, WSF asked itself the following questions:

- What is the optimal size of vessel for most WSF routes?
- What advantages are there in consolidating the varied number of vessel classes?
- Are there vessels in the current fleet that are suitable replacements for the routes from which those older vessels are being retired?
- What works best for the system as a whole in the long term?

Determining The Optimal Size of Vessels in WSF's Fleet

Vessels are assigned to routes based on a combination of matching operating characteristics to the traffic and crossing time requirements. As a rule, it is more efficient to use larger vessels on routes when traffic demands warrant, as economies of scale (measured in operating costs per vehicle space delivered) of operation and capital construction improve with larger vessel sizes.

There are exceptions to the "bigger is better" rule, however; otherwise WSF would be moving towards having a fleet of two hundred car Jumbo ferries. For routes of short to medium length of up to 7 or 8 nautical miles in length, vessels of a more mid-size (130-car) are more efficient than large ones, as the economies of scale of operating a larger vessel are diminished when the proportionately longer load/offload time offsets the crossing time advantage. Also, some routes simply do not have the traffic demands for a larger boat. There are also size restrictions on some routes, such as the San Juan Islands, where WSF does not assign anything larger than a super class due to less than adequate terminal facilities (single lane offloading and loading) and supporting roadside infrastructure.

Even though a 130-car vessel is the most efficient vessel for a route of this length, the current location of the Keystone terminal within a man-made harbor restricts the size of vessels on the Port Townsend route to one of the smallest classes, the Steel Electric Class. The Sidney, B.C. route can only be served by vessels outfitted to meet international safety standards; only two vessels in WSF's current fleet are so equipped. And some routes are better served with vessels that have a single car deck, such as the San Juan Interisland route, due to the complex multi-destination loading and the need to load vehicles pointing in different directions.

As a rule, though, WSF has determined through the use of a cost per vehicle space delivered model (which takes into account operating costs, route length, speed of vessel

and load/unload time) that the 130-car vessel is the least expensive to operate on short to medium length routes, and that the Jumbo Class is marginally more efficient on medium to long length routes. Table 1 shows examples of how hourly cost per vehicle space delivered varies by vessel class and route length. A complete table of this model is attached as an appendix.

Table 1 – Hourly Costs Per Vehicle Space Delivered

Vessel Class	Normalized Rated Vehicle Capacity	Mukilteo/Clinton (2.3 Nautical Miles)	Port Townsend/Keystone (4.3 Nautical Miles)	Seattle/Bainbridge (7.5 Nautical Miles)	Anacortes/Friday Harbor (16.8 Nautical Miles)
Jumbo Mark II	202	$2.69	$3.26	$4.18	$6.86
Super Class	144	$2.96	$3.73	$4.97	$8.52
New 130-car Issaquah	133	$2.24	$2.92	$4.00	$7.16
Evergreen State Class	87	$3.03	$4.21	$6.11	$11.67
Steel Electric	64	$3.03	$4.41	$6.61	$12.94

Shaded: Least cost per vehicle space delivered.

Notes:

- Rated capacity updated based on standard 18.5'car length, 2.5 feet between vehicles, and accounting for car deck space lost to installation of elevators and Marine Evacuation System access corridors.
- Economies of scale for vessel improve with vessel growth
- On shorter routes, longer load/offload times makes the largest vessel (jumbo) less advantageous so economies of scale improvement maximize at the Issaquah 130 size.
- Of the vessels shown, Steel Electric size vessels are least efficient based on cost of space delivered.
- Evergreen State class vessels (built in 1950's) are larger than the Steel Electric size but also have higher operating costs; operating cost per vehicle space delivered is the same with these two classes on a really short route like Mukilteo/Clinton; however the Evergreen Class become marginally more efficient than Steel Electrics as route length grows.
- New Issaquah 130 size offers the breakthrough with operating costs not much greater than an Evergreen State class but considerably better payload. Potential for additional fuel savings with a streamlined hull design would improve the cost per space delivered even more.

- Super class vessels built in the mid-1960's, now rated at 144 vehicles, are burdened by operating costs close to the Jumbo class (202 vehicles) but payload capabilities closer to an Issaquah 130 class.

- Jumbo Mark II vessels come out as the most efficient vessel in the fleet for the medium to longer routes, with Seattle/Bainbridge as the "breakpoint" where both the Issaquah 130 and Jumbo Mark II vessels are essentially the same cost per space delivered. There are limited applications to the assignment of Jumbo sized vessels, however, to the Edmonds, Bainbridge and Bremerton routes. The Jumbo Mark I and Mark II fleet of five serve as a sufficient pool to draw from for that service area.

Summary of Replacement of Steel Electric Class and Rhododendron

When presented with the opportunity to replace the retiring vessels with small vessels more or less in kind (perpetuating less than optimal vessel sizes in WSF's fleet), or to position the fleet to be more flexible, interchangeable, and set the stage for future vessel purchases, the conclusion to replace these vessels with a more mid-sized 130-car vessel modeled after the Expanded Issaquah Class was reached with the following criteria:

- ***Increase the number of optimally efficient vessels in the system*** – the 130-car sized vessel is clearly superior in terms of operating costs per vehicle space delivered on routes less than four and a half miles in length, and second only to the Jumbo classes on routes longer than that. WSF can only effectively use Jumbo class vessels on three of its routes (Bainbridge, Bremerton and Kingston). Since a fleet of five of these vessels is already in service on those routes, building more Jumbo class vessels is really not necessary and would have limited applications.

- ***Accommodate modest growth on some routes*** – the addition of 130-car vessels to the fleet will allow accommodation of growth on some routes – specifically, the Fauntleroy route will see an 87-car vessel replaced by a 130-car vessel, the San Juan domestic route will see an 87-car vessel replaced by a 130-car vessel, and the Port Townsend/Keystone route will see improvements during the parts of the year and time periods in the summer schedule when only one vessel is currently operating. Secondary benefits will occur on the Point Defiance/Tahlequah route, where the 60-car Rhododendron is replaced by an 87-car vessel, and San Juan interisland where a 75-car Steel Electric is replaced by an 87-car vessel. WSF's preliminary long range forecasts for the entire system indicate a 50% increase in ridership by 2020 and a 70% increase by 2030.

- ***Opportunity to provide overall improvement in capacity at Port Townsend with lower vessel capital costs*** – capacity will be maintained during the peak season time periods when the second boat is now operating (mid-May through mid-October, mid-morning through late afternoon) and increased during those time

periods of the year (mid-October through mid-May) and times of day (early morning and evenings during the summer) when only one vessel is currently operating.

- ***Benefits to route capacity*** - assignment of the 130-car vessel will effectively restore the vehicle delivery capability cut from the route in 2000 when the hours of the second vessel were reduced from 16 hours/day to 8 hours/day as part of a systemwide reduction in operating costs, yet do it with approximately the same operating costs. This will improve service during many weekends in the summer and early spring/late fall when additional capacity is needed but currently requires a second vessel to do so.

Advantages in Consolidating Vessel Classes

There currently are five 130-car vessels in the fleet; once a fleet of four new 130-car vessels are constructed, the total comes to nine. With the retirement of the Steel Electric Class vessels and the Rhododendron, the number of separate vessel classes would be reduced by two, reducing crew training costs and providing much more flexibility in substitution during scheduled vessel maintenance or in the event of vessel breakdowns. Routes dependent upon a narrow pool of vessels have been at a disadvantage during times of vessel breakdowns; for example, the Port Townsend/Keystone route, dependent solely upon the Steel Electric class vessels, has had two occasions over the past decade (summers of 1995 and 1997) where service has been disrupted significantly (one vessel service instead of the normal two-vessel summer schedule) by mechanical failures in that particular vessel class and no replacement available.

Use of Existing Vessels in Filling Some of the Roles of the Retired Vessels

The vessel reassignment will allow a more efficient utilization of remaining slow and small vessels in the fleet in the Evergreen State class: one will replace a Steel Electric Class vessel on the San Juan interisland route (where the capacity of the Steel Electric is starting to be overtaxed in the summer months) and one will replace the Rhododendron on the Point Defiance/Tahlequah route, providing additional capacity off the south end of Vashon Island in order to provide an alternative to the congested Fauntleroy route.

What's Best For the System in the Long Run

WSF should use every opportunity to prune out less efficient vessels from its fleet and replace them with more efficient vessel sizes. Building vessels with operating costs per unit of delivery significantly lower than those that they are replacing positions the system to accommodate future growth much more cost effectively. There will continue to be a for vessels slower and smaller than the Issaquah 130 for the San Juan Inter-island and Point Defiance – Tahlequah routes. These can be served by the two remaining 87-car Evergreen State Class vessels.

II. Vessel Planning and Keystone Route

Since WSF announced plans to deploy a 130-car vessel on the Keystone –Pt Townsend, and to either relocate Keystone Terminal or modify Keystone Harbor to accommodate the new vessels, arguments have been put forward in favor of keeping small, specialized vessels on the route. The following facts are offered in response to these arguments:

- The potential application for slow and small 65-car vessels in the rest of the system simply isn't there, even if it were a more cost-effective option than operating a smaller fleet of more mid-sized vessels. Single slip constraints at Fauntleroy preclude evolving to a greater number of smaller vessels and the small size simply would not meet current and projected demand for the Point Defiance, San Juan Interisland, and a future "split route" Anacortes-Lopez route.

- WSF does and will continue to have a need for vessels of various sizes. It's just that for most routes and applications, the 130-car size is optimal. WSF has in its inventory larger and smaller vessels, which will continue to serve routes when an individual route's operating environment requires something other than a 130-car vessel.

- WSF cannot responsibly plan for a stagnant ridership over the next few decades. Overall system ridership is projected to grow 50% by 2020 and 70% by 2030, based on state and regional population and employment growth estimates. Although vehicle volumes are projected to grow at a slower rate, WSF needs to position itself to accommodate current and projected demand in the most cost effective manner. WSF acknowledges that there has been a stable or downward trend over the last few years but feels this is largely driven by steep fare increases in response to loss of tax subsidy and a slowdown in the regional economy. A look at WSF's historical ridership (Figure 2) indicates that while there have been times in WSF's history when ridership has been soft or declining, the overall trend has been upward.

Cost-effectiveness of a 130-car vessel on the Keystone-Pt. Townsend Route

When evaluating vessel construction, operations, and long term preservation costs, it is more cost effective to replace the current small two boats on the Keystone route with a single larger one. Capacity will be maintained during the peak season time periods when the second boat is now operating (mid-May through mid-October, mid-morning through late afternoon) and increased during those time periods of the year (mid-October through mid-May) and times of day (early morning and evenings during the summer) when only one vessel is currently operating.

Assignment of the 130-car vessel will effectively restore the vehicle delivery capability cut from the route in 2000 when the hours of the second vessel were reduced from 16 hours/day to 8 hours/day as part of a systemwide reduction in operating costs, yet do it with approximately the same operating costs. This will improve service during many weekends in the summer and early spring/late fall when additional capacity is needed but currently requires a second vessel to do so.

Appendix A – Planned Vessel Assignments

Route	Summer	Fall/Winter/Spring
Anacortes/San Juans/ Sidney, B.C.	Super Super Super Existing 130 Evergreen	Super New 130 Existing 130 Evergreen
Port Townsend/ Keystone	New 130	New 130
Mukilteo/ Clinton	New 130 Existing 130	New 130 Existing 130
Edmonds/Kingston	Jumbo Mark II Jumbo Mark I	Jumbo Mark II Jumbo Mark I
Seattle/ Bainbridge	Jumbo Mark II Jumbo Mark II	Jumbo Mark II Jumbo Mark II
Seattle/ Bremerton	New 130 Jumbo Mark I	New 130 Super
Fauntleroy/ Vashon/ Southworth	Existing 130 Existing 130 Sealth	Existing 130 Existing 130 Sealth
Point Defiance/ Tahlequah	Evergreen	Evergreen
Maintenance/ Relief	New 130* Existing 130 Super **	Jumbo Mark I Super Existing 130 Super **

* Potentially available as an additional summer vessel on a recreational route
** MV Hyak, without major preservation, will be a part-time relief boat

Appendix B – Detail of Vessel Optimization Spreadsheet

Operating Costs and Delivery Rates per Vessel per Routes - November 2004 Update

Lightly Shaded: Most efficient vessel class, assuming 100% utilization
Medium Shaded: Most efficient vessel class incorporating route restrictions

	Route Length Nautical Miles	Jumbo Mk II	Jumbo	Super	New Exp Issaquah	Existing Issaquah	Sealth	Evergreen	Steel Electric	Hiyu
Point Defiance-Tahlequah	1.5	5	7	9	1	3	4	8	6	2
Delivery Rate (veh/Hour)		422	394	363	369	343	290	262	213	150
Total Cost per Car*		$2.46	$2.55	$2.65	$1.96	$2.11	$2.39	$2.56	$2.49	$2.04
Fauntleroy-Vashon	2.8	3	4	7	1	2	5	8	9	6
Delivery Rate (veh/Hour)		366	342	305	301	279	230	201	157	101
Total Cost per Car*		$2.83	$2.94	$3.16	$2.41	$2.60	$3.02	$3.33	$3.38	$3.03
Fauntleroy-Southworth	4.1	3	4	5	1	2	5	7	8	6
Delivery Rate (veh/Hour)		324	303	263	255	237	190	164	124	76
Total Cost per Car*		$3.20	$3.32	$3.65	$2.85	$3.06	$3.65	$4.10	$4.29	$4.03
Vashon-Southworth	1.6	5	7	9	1	3	4	8	6	2
Delivery Rate (veh/Hour)		417	389	358	363	337	284	256	207	145
Total Cost per Car*		$2.49	$2.58	$2.69	$2.00	$2.15	$2.44	$2.62	$2.56	$2.11
Seattle-Bremerton	13.5	2	3	5	1	4	6	7	9	8
Delivery Rate (veh/Hour)		168	157	129	119	110	84	74	54	32
Total Cost per Car*		$6.18	$6.41	$7.49	$6.11	$6.58	$8.29	$9.06	$9.86	$9.56
Seattle-Bainbridge Island	7.5	2	4	5	1	3	6	7	8	9
Delivery Rate (veh/Hour)		248	232	194	181	168	131	110	80	46
Total Cost per Car*		$4.18	$4.34	$4.97	$4.00	$4.31	$5.28	$6.11	$6.61	$6.65
Edmonds-Kingston	4.5	3	4	5	1	2	6	8	9	7
Delivery Rate (veh/Hour)		312	292	252	242	225	181	155	116	71
Total Cost per Car*		$3.32	$3.45	$3.81	$2.99	$3.22	$3.84	$4.33	$4.57	$4.31
Mukilteo-Clinton	2.3	4	6	7	1	2	5	8	8	3
Delivery Rate (veh/Hour)		385	360	325	324	301	249	221	175	115
Total Cost per Car*		$2.69	$2.79	$2.96	$2.24	$2.41	$2.78	$3.03	$3.03	$2.66
Keystone-Port Townsend	4.3	3	4	5	1	2	6	8	9	7
Delivery Rate (veh/Hour)		318	297	258	249	231	185	159	120	73
Total Cost per Car*		$3.26	$3.38	$3.73	$2.92	$3.14	$3.74	$4.21	$4.41	$4.19
Anacortes-Interisland	13.6	1	3	5	2	4	6	7	8	9
Delivery Rate (veh/Hour)		157	147	118	106	99	76	63	44	25
Total Cost per Car*		$6.60	$6.85	$8.19	$6.81	$7.34	$9.18	$10.70	$11.95	$12.24
Anacortes-Lopez-Shaw-Orcas	15.3	1	3	5	2	4	6	7	8	9
Delivery Rate (veh/Hour)		142	133	106	96	89	68	57	40	22
Total Cost per Car*		$7.28	$7.56	$9.03	$7.54	$8.12	$10.28	$11.85	$13.22	$13.91
Anacortes-Friday Harbor	16.8	1	2	5	3	4	6	7	8	9
Delivery Rate (veh/Hour)		151	141	113	101	94	71	57	41	22
Total Cost per Car*		$6.86	$7.12	$8.52	$7.16	$7.71	$9.76	$11.67	$12.94	$13.91
Anacortes-Friday-Lopez	17.0	1	2	5	3	4	6	7	8	9
Delivery Rate (veh/Hour)		141	131	104	93	86	66	54	38	21
Total Cost per Car*		$7.38	$7.66	$9.27	$7.79	$8.39	$10.56	$12.42	$13.81	$14.57
Anacortes-Shaw-Orcas	15.1	1	3	5	2	4	6	7	8	9
Delivery Rate (veh/Hour)		151	141	113	102	95	72	59	42	23
Total Cost per Car*		$6.86	$7.12	$8.52	$7.09	$7.63	$9.64	$11.33	$12.68	$13.30
Anacortes-Islands-Sidney	38.2	1	2	5	3	4	6	7	8	9
Delivery Rate (veh/Hour)		77	72	55	48	45	33	27	19	10
Total Cost per Car*		$13.45	$13.96	$17.47	$15.08	$16.24	$20.84	$24.84	$28.24	$30.60
Seattle-Vashon-Southworth	11.5	1	3	5	2	4	6	7	8	9
Delivery Rate (veh/Hour)		195	182	148	135	125	96	79	56	32
Total Cost per Car*		$5.31	$5.52	$6.51	$5.37	$5.78	$7.21	$8.46	$9.41	$9.56